

**SECTION 26 05 41
UNDERGROUND ELECTRICAL CONSTRUCTION**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation and connection of manholes, handholes and ducts to form a complete underground raceway system.
- B. "Duct" and "conduit", and "rigid metal conduit" and "rigid steel conduit" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

- A. Not Used
- B. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings and boxes for raceway systems.
- E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
- C. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
 - 1. Certification that the materials are in accordance with the drawings and specifications.
 - 2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.4 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

- A. American Concrete Institute (ACI):
 - Building Code Requirements for Structural Concrete
 - 318/318M-2005 Building Code Requirements for Structural Concrete &
Commentary
 - SP-66-04 ACI Detailing Manual

- B. American Society for Testing and Materials (ASTM):
 - C478/C478M 2006(b).....Standard Specification for Precast Reinforced Concrete Manhole Sections
 - C990 REV A 2003Standard Specification for joints concrete pipe, Manholes and Precast Box using performed flexible Joint sealants.
- C. Institute of Electrical and Electronic Engineers (IEEE):
 - C2-2002National Electrical Safety Code
- D. National Electrical Manufacturers Association (NEMA):
 - RNI 2005Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
 - TC 2 2003Electrical Polyvinyl Chloride (PVC) Tubing And Conduit
 - TC 3-2004PVC Fittings for Use With Rigid PVC Conduit And Tubing
 - TC 6 & 8 2003PVC Plastic Utilities Duct For Underground Installations
 - TC 9-2004Fittings For PVC Plastic Utilities Duct For Underground Installation
- E. National Fire Protection Association (NFPA):
 - 70 2005National Electrical Code (NEC)
- F. Underwriters Laboratories, Inc. (UL):
 - 6-2004Electrical Rigid Metal Conduit-Steel
 - 467-2004Standard for Grounding and Bonding Equipment
 - 651-2005Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
 - 651A-2003.....Type EB and A Rigid PVC Conduit and HDPE Conduit, (RTRC)
 - 651B-2002.....Continuous Length HDPE Conduit
- G. U.S. General Services Administration (GSA):
 - A-A-60005-1998.....Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
 - SS-S-210A-1981Sealing Compound, Preformed Plastic for Expansion joints And Pipe Joints

PART 2 - PRODUCTS

2.1 CONCRETE MANHOLES AND HARDWARE: NOT USED

2.2 FIBERGLASS HANDHOLES: NOT USED

2.3. DUCTS:

- A. Number and sizes shall be as shown on drawings.
- B. Ducts (concrete encased):
 - 1. Plastic Duct:
 - a. UL 651 and 651A Schedule 40 PVC.
 - b. Duct shall be suitable for use with 90 degree C rated conductors.

2. Conduit Spacers: Prefabricated plastic.

2.4 GROUNDING

- A. Rods: Per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS and UL 467
- B. Ground Wire: Stranded bare copper 6 AWG minimum.

2.5 WARNING TAPE:

Standard 4-mil polyethylene 3 inch wide tape, type, red with black letters, imprinted with "CAUTION BURIED ELECTRIC CABLE BELOW".

2.6 PULL ROPE:

Plastic with 890N (200 pound) minimum tensile strength.

PART 3 - EXECUTION

3.1 MANHOLE AND HANDHOLE CONSTRUCTION AND INSTALLATION NOT USED

3.2 TRENCHING

- A. Not Used
- B. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.
- C. Cut the trenches neatly and uniformly.
- D. For Concrete Encased Ducts:
 1. After excavation of the trench, stakes shall be driven in the bottom of the trench at 4 foot intervals to establish the grade and route of the duct bank.
 2. Pitch the trenches uniformly towards manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts towards buildings wherever possible.
 3. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.
 4. After the concrete encased duct has sufficiently cured, the trench shall be backfilled to grade with earth, with appropriate warning tape attached.
- E. Conduits to be installed under existing paved areas, roads, and railroad tracks that are not to be disturbed shall be jacked into place. Conduits shall be PVC-coated rigid metal.

3.3 DUCT INSTALLATION

- A. General Requirements:
 1. Ducts shall be in accordance with the NEC and IEEE C2, as shown on the drawings, and as specified.
 2. Slope ducts to drain towards manholes and handholes, and away from building and equipment entrances. Pitch not less than 4 inches in 100 feet.

3. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be PVC-coated galvanized rigid steel, and shall extend a minimum of 5 feet outside of building foundation.
 4. Stub-ups, sweeps, and risers to equipment mounted on outdoor concrete slabs shall be PVC-coated galvanized rigid steel, and shall extend a minimum of 5 feet away from edge of slab.
 5. Install insulated grounding bushings on the terminations.
 6. PVC-coated rigid steel conduits shall be coupled to the ducts with suitable adapters, and the whole encased with 3 inches of concrete.
 7. PVC coated rigid steel conduit turns of direction for all duct lines shall have minimum 4 feet radius in the horizontal and vertical directions. PVC conduit sweeps for all duct lines shall have a minimum 40 feet radius in the horizontal and 4 feet in the vertical directions. Where a 4 feet radius is not possible, horizontal turns of direction shall be rigid steel.
 8. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 3 inches above bottom of trench during the concrete pour. Spacer spacing shall not exceed 5 feet.
 9. Duct lines shall be installed no less than 12 inches from other utility systems, such as water, sewer, and chilled water.
 10. Clearances between individual ducts:
 - a. For like services, not less than 3 inches.
 - b. For power and signal services, not less than inches.
 - c. Provide plastic spacers to maintain clearances.
 - d. Provide nonferrous tie wires to prevent displacement of the ducts during pouring of concrete. Tie wires shall not act as substitute for spacers.
 11. Duct lines shall terminate at window openings in manhole walls as shown on the drawings. All ducts shall be fitted with end bells.
 12. Couple the ducts with proper couplings. Stagger couplings in rows and layers to insure maximum strength and rigidity of the duct bank.
 13. Keep ducts clean of earth, sand, or gravel during construction, and seal with tapered plugs upon completion of each portion of the work.
- B. Concrete Encased Ducts and Conduits:
1. Install concrete encased ducts for medium and high voltage systems, low voltage systems, and signal systems unless otherwise shown on the drawings.
 2. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts shall be uniform in size and material throughout the installation.
 3. Tops of concrete-encased ducts shall be:
 - a. Not less than 24 inches and not less than shown on the drawings, below finished grade.

- b. Not less than 30 inches and not less than shown on the drawings, below roads and other paved surfaces.
 - c. Conduits crossing under grade slab construction joints shall be installed a minimum of 4 feet below slab.
 - 4. Extend the concrete envelope encasing the ducts not less than 3 inches beyond the outside walls of the outer ducts and conduits.
 - 5. Within 10 feet of building, manhole and handhole wall penetrations, install reinforcing steel bars at the top and bottom of each concrete envelope to provide protection against vertical shearing.
 - 6. Install reinforcing steel bars at the top and bottom of each concrete envelope of all ducts underneath roadways and parking areas.
 - 7. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, handholes, ducts, conduits, and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to insure smooth durable transitions.
 - 8. Conduit joints in concrete may be placed side by side horizontally but shall be staggered at least 6 inches vertically.
 - 9. For medium voltage duct bank installations, a grounding conductor shall be extend along all electrical duct banks including stubs through each electrical distribution system manhole and to each transformer and switching-station installation.
 - 10. Duct Bank Markers:
 - a. Duct bank markers, where required, shall be located at the ends of duct banks except at manholes or handholes at approximately every 200 feet along the duct run and at each change in direction of the duct run. Markers shall be placed 2 feet to the right of the duct bank, facing the longitudinal axis of the run in the direction of the electrical load.
 - b. The letter "D" with two arrows shall be impressed or cast on top of the marker. One arrow shall be located below the letter and shall point toward the ducts. Second arrow shall be located adjacent to the letter and shall point in a direction parallel to the ducts. The letter and arrow adjacent to it shall each be approximately 2-inches long. The letter and arrows shall be V-shaped, and shall have a width of stroke at least 1/4 inch at the top and a depth of 1/4 inch.
 - c. In paved areas, the top of the duct markers shall be flush with the finished surface of the paving.
 - d. Where the duct bank changes direction, the arrow located adjacent to the letter shall be cast or impressed with an angle in the arrow the same as the angular change of the duct bank.
- C. Direct Burial Duct and Conduits:

1. Install direct burial ducts and conduits only where shown on the drawings. Provide direct burial ducts only for low voltage systems.
 2. Join and terminate ducts and conduits with fittings recommended by conduit manufacturer.
 3. Direct burial ducts and conduits are prohibited under railroad tracks.
 4. Tops of ducts and conduits shall be:
 - a. Not less than 24 inches and not less than shown on the drawings, below finished grade.
 - b. Not less than 30 inches and not less than shown on the drawings, below roads and other paved surfaces.
 5. Do not kink the ducts or conduits.
- D. Concrete-Encased and Direct Burial Duct and Conduit Identification: Place continuous strip of warning tape approximately 12 inches above ducts or conduits before backfilling trenches. Warning tape shall be preprinted with proper identification.
- E. Spare Ducts and Conduits: Where spare ducts are shown, they shall have a nylon pull rope installed. They shall be capped at each end and labeled as to location of the other end.
- F. Duct and Conduit Cleaning:
1. Upon completion of the duct bank installation or installation of direct buried ducts, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 12 inches long, and shall have a diameter not less than 1/2 inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than the diameter of the duct.
 2. Mandrel pulls shall be witnessed by the Resident Engineer.
- G. Duct and Conduit Sealing: Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.
- H. Connections to Manholes: Duct bank envelopes connecting to underground structures shall be flared to have enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is poured to assure a seal between the envelope and the wall of the structure.
- I. Connections to Existing Manholes: For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and extend into the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

- J. Connections to Existing Ducts: Where connections to existing duct banks are indicated, excavate around the duct banks as necessary. Cut off the duct banks and remove loose concrete from the conduits before installing new concrete-encased ducts. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks.
- K. Partially Completed Duct Banks: During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 1 foot apart. Restrain reinforcing assembly from moving during pouring of concrete.

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